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Clean water and how to get it on the farm.

Trullinger

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CLEAN WATER AND HOW TO GET IT ON THE FARM.

BY

ROBERT W. TRULLINGER,
Specialist in Rural Engineering, Office of Experiment Stations.

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CLEAN WATER AND HOW TO GET IT ON THE FARM.

By Robert W. Trullinger,
Specialist in Rural Engineering, Office of Experiment Stations.

THE improvement of farm water supplies, a matter long neglected by American farmers, is now in some degree attracting the consideration it merits. It is becoming widely recognized that in many cases the farm water supplies are perhaps dangerously polluted. In addition, those who are so unfortunately situated as to be required to carry water from the well to the house are becoming extremely weary of this drudgery. Every farm must have a water supply, and it is safe to say that a plentiful supply of clean water, made available where most used by the mere turning of a faucet, or at the worst by pumping without carrying, is one of the main factors in making modern farm home life desirable.

Securing clean water in the farm house is a somewhat different problem from that of providing a city or town supply. In the latter case the purity and availability of the water supply is taken care of by engineering and public-health officials; in the former a personal understanding of the dangers which lie in a polluted water supply is necessary, and a great deal of resourcefulness is often required to secure an unpolluted supply and to prevent the drudgery of carrying water.

THE DIFFERENCE BETWEEN CLEAN WATER AND MERELY CLEAR WATER.

Perhaps the most important consideration in connection with the farm water supply is to get clean water. In the past clean water has usually meant clear water. But it is now known that water to be clean must not only be clear, but it must be pure. Water may be vilely polluted and at the same time be beautifully clear and sparkling. It may be clear and yet contain the invisible and deadly germs of typhoid fever or other intestinal disorders. It may also contain considerable poisonous matter in solution. A polluted water supply is evidence of the existence of bad sanitary conditions which it is of the utmost importance to remedy.

The main sources of water for farm use are streams, springs, cisterns, and wells. Perhaps the majority of supplies are derived from wells and cisterns, although springs are often used. In rarer instances, where other supplies are difficult to obtain, stream water is used.

STREAM WATER UNSAFE TO USE.

With the growth of population and development of industries there is progressive pollution of streams, so that in the more thickly settled regions streams not already contaminated or subject to pollution are very rare. Surface-water supplies from small streams should, therefore, never be used for household purposes unless no other supply is available. In the event that it must be used such water should be clear and should be thoroughly boiled. Other processes of purification, such as filtering, treating with chemicals, or distilling, are also sometimes used, but are generally impracticable from the farm standpoint. Under ordinary conditions surface water of any kind should be looked upon with considerable suspicion.

THE FARM WELL.

The well is the most commonly used source of farm water supply. It may be a shallow dug or driven well or a deep dug or bored well. It may be said, however, that the majority of shallow dug wells on farms where contamination is present are contaminated. This has been abundantly proved by investigations made by this department and by other Federal and State institutions. The State of Illinois has made rather extended surveys of its farm water supplies, and the report of these surveys shows that out of a large number of typical shallow wells examined three-fourths were dangerously polluted. The boards of health of Indiana, Minnesota, Missouri, North Carolina, Virginia, and other States have published official statements no less startling. In a large number of cases it is stated that pollution might have been prevented by proper precautionary measures.

Contaminated water is, however, by no means confined to shallow wells. Contaminated surface water often gains access to deep wells at the top in the same manner that it gains access to shallow wells. Poorly protected shallow wells are sometimes polluted through the soil, although this does not occur as often as is commonly thought. Deep wells, if not cased, may be likewise polluted through the soil or through rock fissures, and if cased, surface water may follow the casing to the bottom and thus enter the well. However, deep wells are as a rule less likely to be polluted than are shallow wells.

A more vivid impression of common causes of unclean farm wells can perhaps be gained from the accompanying illustrations. These represent existing conditions, most of which were photographed by the writer.

Plate VII, figure 1, shows the back yard of a local health officer in a farming community. The rather small area shown comprised a hogpen, chicken yard, and cow lot, and contained a barn, manure pile, open privy, chicken house, and shallow dug well. The pump is of the old wooden type and is located at the foot of the stairs to the back porch. Waste water and slops are dumped into a small ditch presumably intended to drain away from the house and well, but which as a matter of fact fails to drain at all.

The open well shown in Plate VII, figure 2, is located much lower than, and within 25 feet of, the barn and chicken yard. The well in Plate VII, figure 3, contained water dogs, and in fact any small animal could crawl under the loose curbing and fall into the well. Plate VII, figure 4, represents a back yard as photographed by the Indiana State Board of Health. An examination of the water from the well showed it to be dangerously polluted. Plate VII, figure 5, shows an open well with old-fashioned wooden curb, pulley, and buckets which is subject to surface wash from several sources of pollution. The well is a shallow well about 15 feet deep, loosely lined with stones. An inspection of the inside revealed moss and slime hanging down into the water, probably resulting from surface wash.

The soil in which a well is sunk may more or less affect the extent to which it is polluted. Often a shallow well in a tough clay or hardpan soil which extends to the water-bearing stratum is fairly safe from pollution if protected at the surface. Deep wells in very sandy soils, if protected at the top, are not often polluted. Perhaps the most dangerous wells are those in a limestone region. The limestone often contains open underground passages or channels. These channels frequently lead to open fissures or sinks at the surface, into which filth, sewage, garbage, and other contaminating matter is dumped. Rain water can carry these impurities directly to wells through the channels.

HOW TO KEEP THE WELL WATER CLEAN.

PRELIMINARY MEASURES.

Obviously the logical first step in securing a clean well-water supply is to remove all the sources of possible contamination. Among the worst of these are the open privy vault, the leaching cesspool, and barnyard filth. A well in ordinary pervious soil located lower than, and within 100 feet of, any of these is almost certain to be polluted. Even though the well is located on higher ground than these sources of contamination, heavy pumping or dry weather may so lower the ground-water level that it will reach the zone of contamination and thus pollute the well. It is evident, therefore, that the open privy vault and leaching cesspool should be discarded and a sewage purification system, or at least a sanitary privy, be used instead. Sewage, garbage, manure, or other waste should never be dumped into sinks or fissures, and most certainly never into old abandoned wells. An old well used for this purpose is very likely to communicate directly with the water-bearing stratum from which other wells in the immediate vicinity draw their supply. Slops or waste water should never be thrown out of the back door or window onto the ground. If the pigs and chickens must run at large they should at least be kept away from the well. A box built around the pump and filled with manure in winter is an extremely unsafe way to prevent the pump from freezing.

Concrete manure pits, impervious floors, and water-tight drains are desirable features for farm buildings. If these are beyond the farmer's purse the manure pile should at least be placed a safe distance away from the well.

The well itself should be located as high as possible with respect to buildings, stock pens, and chicken yards, and as far away from all sources of contamination as convenience and local surroundings will permit.

FINAL MEASURES.

The final safeguards to a well-water supply are to give the well an impervious lining of tile, cemented brick, iron casing, or concrete, and to provide a water-tight curb, not only to keep out surface wash, animals, and vermin, but to prevent the pump drip and dirt from shoes and buckets from entering the well. It is well here to suggest that those who use the well should attempt to remove the most of the dirt from their shoes before stepping onto the well curb.

Plate VIII, figure 1, shows a well-protected dug well. It is located on high ground and has an impervious lining of 30-inch vitrified tile with tightly cemented joints. The top tile extends a foot above the ground and is capped with concrete. The barns, pens, etc., are located at a safe distance and on lower ground, the farmer preferring to pipe or carry the water to these places.

Concrete makes a good lining for a dug well, owing to the fact that if a mixture of mushy consistency is used an almost water-tight bond can be effected between the soil and the concrete, thus preventing in a measure the entrance of surface water to the well by this route. A concrete well curb, as shown in Plate VIII, figure 2, can always be used with advantage. Concrete drains to carry away the pump drip and surface wash, as shown in Plate VIII, figure 4, are desirable. Note the clean-looking surroundings of this well.

Deep wells are usually lined with smaller tile or with iron casing. Small tile casings, however, where the joints are not cemented, allow contaminated surface and soil water to enter the well. The iron casing is more frequently used in deep bored or punched wells of smaller diameter, being usually driven into place. With such a casing the well can be polluted only at the bottom.

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Ordinarily for shallow water supplies a driven well is safest and the most satisfactory, particularly if the soil is sandy. It consists mainly of a point and screen attached to a pipe which is driven until the water-bearing stratum is encountered. The screen on the point prevents coarse matter from being pumped up.

From what has been said regarding wells it may be concluded that the watchword should be "Keep the surroundings clean and protect the well from surface wash and soil drainage." For further safety it is a good idea to have the water tested occasionally for signs of pollution.

HOW SPRINGS ARE POLLUTED AND HOW TO KEEP THEM CLEAN.

The farmer who has a good spring which can be piped to the house is fortunate indeed. Springs are, however, subject to contamination from the same sources as wells, although more often contaminated by surface wash and because animals have access to them.

The water from springs which are open and unprotected from surface wash and from stock is often used for drinking purposes. Plate IX, figure 1, shows a spring the water from which is commonly used for drinking, especially by picnickers and wayfarers. This spring, as can be seen, is located directly under a very popular roadway, and although walled in, has inadequate protection from the filth which during rains will wash from the roadway. Plate VIII, figure 3, is a historic farm spring which is carefully walled in but forms an excellent catch basin for the surface wash from the surrounding hog-pens, chicken yards, barns, etc., located on higher ground.

The proper location for a spring is the same as for a well. If it occurs in a good location it should first be fenced off from stock and then walled in with tile or concrete to form a reservoir, which should be well covered.

Plate IX, figure 4, is an example of a well-protected small spring which is located just above the foot of a hill. A 36-inch vitrified tile was placed around the spring so as to form a reservoir, and it was then covered as is shown. Owing to the location and manner of protection there is little chance for this spring to become polluted from surface wash. Small springs can frequently be protected in this way, and if so treated are often the best of water supplies.

Springs, especially those occurring in limestone regions, should be kept under close observation and should be particularly noticed after rains for any signs of turbidity, which may indicate pollution from near or distant surface sources. Frequent examinations for pollution may prevent trouble, and if there is any doubt whatever about the purity of the spring, the water should be boiled carefully before drinking.

RAIN WATER AND CISTERNS.

In many cases rain water is used for laundry purposes and sometimes for drinking and cooking. It is often the only available source of soft water. If rain water is to be used, a cistern for storage purposes and usually a filter for partially purifying the water are necessary.

Roofs, particularly shingled roofs, collect much dust and dirt from the roads, and gutters and eave troughs are often filled with leaves, dirt, and bird droppings. It is well to keep the gutters clean, even though the rain water is not used, but if it is used the importance of clean gutters is vastly increased. However careful one may be, the roof is certain to be dirty when dry. It is therefore extremely important that a switch and by-pass be provided on the rain-water pipe, so that at the beginning of rains the filth from the roof may be washed to the outside before any rain water is admitted to the cistern.

The necessary size of the cistern will depend on the amount of water used daily by the family, the annual rainfall in the locality, and the size of the contributing roof area. If the rainfall is well distributed throughout the year, the capacity of the cistern may be only sufficient for one or two weeks' supply. In localities where long intervals often occur between periods of rainfall, and where much dependence is placed on the rain water, it is advisable to provide a cistern of sufficient capacity to hold half or three-fourths of the rain which falls annually on the average roof area. The amount available in gallons may be computed approximately by multiplying the roof area in square inches by the rainfall in inches and dividing the product by 231. To take greater advantage of rains, the contributing roof area may be extended by means of proper piping to include roofs of other buildings besides the house.

The cistern may be built of concrete or cemented brick, but in any event if placed underground it should be water-tight, not only to prevent the loss of the stored water, but to prevent the entrance of ground water. If the cistern is constructed of concrete and the surrounding soil is loose and exerts a decided pressure on the walls, the latter should be reinforced close to the inside surface. A mixture of 1 part cement, 2 parts sand, and 4 parts gravel or broken stone may be used in cistern construction. The concrete mixture may be made more waterproof by adding 10 per cent of petroleum residuum oil based on the weight of the cement, or by replacing about 15 per cent of the cement with hydrated lime. Whatever the type of construction, one or two coatings of a strong cement grout, preferably containing about 3 per cent oil, will aid in waterproofing the walls. An overflow pipe, well screened, should be provided in the side, and the cover should be water-tight.

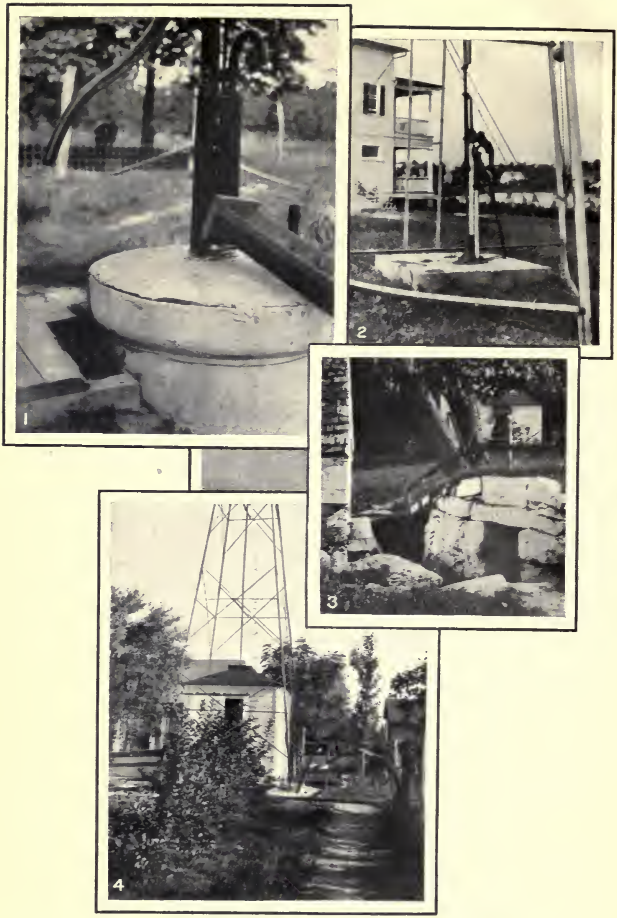
The filtering arrangement may either be in a separate chamber or inside the cistern.

In the first case, a filter bed of sand and gravel is placed in a brick or concrete tank or in a good barrel located preferably close to the cistern. The rain water should be made to spread over the surface of the filter and come in contact with all parts of it, passing completely through before entering the cistern. Figure 3 shows a common type of filter connected with an underground concrete cistern. Such a filter should, in a large measure, purify rain water which passes through it. The filtering material should be renewed at intervals and the collected sediment cleaned out frequently. The cistern shown has a capacity of about 3,800 gallons.

In the second case, the filter usually consists of two walls of brick, 8 to 10 inches apart, the intervening space being filled with coarse sand, fine gravel, or both. Only the vertical joints between the bricks are cemented. A number of loose bricks are placed at several points at the base to permit the removal of the sand or gravel when it becomes clogged. The filter wall should be built in an arch shape to give it

SOME TYPES OF WELL SURROUNDINGS.

Fig. 1.—The back yard of a local health officer's residence. Fig. 2.—A well which the surface wash from the barn during rains will pollute. Fig. 3.—A loose curbing which permits small animals and vermin to fall into the well. Fig. 4.—Well in which the water was badly polluted. Fig. 5.—An old-fashioned open well subject to surface wash.



SOME TYPES OF WELL AND SPRING SURROUNDINGS.

Fig. 1.—A good protection for a dug well. Fig. 2.—Curb good and tight, with pump frame tightly fastened to it. Fig. 3.—Catch-basin type of spring, which one should usually avoid, regardless of its history or popularity. Fig. 4.—A nicely kept well with concrete drains and clean surroundings.

SOME TYPES OF WELL AND SPRING SURROUNDINGS.

Fig. 1.—Spring inadequately protected from surface wash from the road; should be looked on with suspicion. Fig. 2.—An excellent outside elevated tank system. Fig. 3.—Small gas engine directly connected to the pump. Fig. 4.—Spring well protected, and can be tightly covered.

strength. The raw-water compartment should be made much larger than the filtered-water compartment to obtain the benefit of sedimentation before filtration.

Sometimes the filter wall in a cistern consists merely of a wall of porous brick with vertical cemented joints. This type of filter is apt to become clogged and ineffective in time, as far as purification is concerned.

In some localities it is necessary, owing to the height of ground-water level, to build the cistern above ground. In

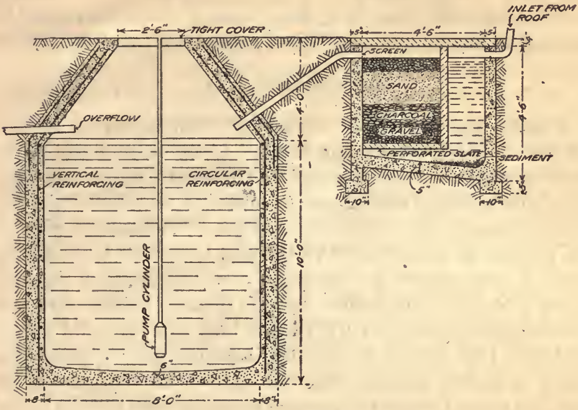


FIG. 3.—A common type of cistern and filter.

such cases the cistern should be well protected to prevent the entrance of filth and the breeding of mosquitoes.

The method of having the filter separate from the cistern, although usually the more expensive, is perhaps the more efficient. There are other simpler and perhaps less expensive cistern arrangements which serve the purpose. The main idea is, however, to purify the water as much as possible before it is used, and to provide effective storage.

HOW TO GET RUNNING WATER IN THE HOUSE.

From the standpoint of convenience, comfort, and refinement, the most important consideration in connection with the farm water-supply problem is to have the water under pressure in an elevated tank or in a hydropneumatic tank and available at the turning of a faucet, or at least available by merely pumping.

The method of hoisting water from the well or spring, pouring it into buckets, and carrying it up porch steps and through doors into the kitchen and to other parts of the house is tiresome and wasteful of energy, and is cruelly and in most cases inexcusably primitive, especially as the task of obtaining the water generally falls in such cases upon the women of the household.

It is desirable, therefore, that running water be available at least in the kitchen, and in a bathroom if possible.

THE SIMPLEST WAY.

Almost any system of obtaining running water in the kitchen is better than none at all. If the well or cistern is located within a short distance of the house, about the simplest and perhaps the cheapest method is to place a pitcher or other pump over a sink in the kitchen. The suction pipe of the pump may be extended to the well and water be obtained when desired merely by pumping; that is, provided the distance to water in the well is not too great. Under ordinary circumstances a pump will lift water only to a height of about 20 feet. One should be careful, therefore, not to place the pump in such a position that the suction lift will exceed 20 feet, for in that event the pump will not operate satisfactorily and likely not at all. It should also be remembered that water flowing through a pipe meets with considerable resistance due to friction, which increases as the velocity of the water and the length of the pipe increase and as the diameter of the pipe decreases. Elbows and bends in the pipe also increase the friction. Pump manufacturers give information in regard to this frictional loss which should always be considered in arranging a pumping system in the kitchen or elsewhere. The allowable distance from the well to the pump for this arrangement will vary with local conditions. The writer has seen cases in which this distance was as high as 150 to 200 feet.

When the housewife is unusually busy in the kitchen it is a waste of time and energy, and perhaps a strain on patience, to stop to pump water. Also the most water is usually needed when she is the busiest. For this reason a water supply under pressure is a great convenience, as it makes it possible to obtain the needed water merely by turning a faucet.

The simplest, and usually the cheapest, method of securing a water supply under pressure is to have an elevated supply tank located at some point 8 or 10 feet higher than the highest faucet.

THE ELEVATED-TANK SYSTEM.

An elevated water-supply tank may be placed in the attic, on the roof, on the windmill tower, on a special tower, or on the silo. It must be high enough to give the desired pressure at points where the water is used. The tank may be of wood or galvanized metal. Its size will depend on the amount of water used daily in the house. A 250 to 500 gallon tank is sufficient for the average family, although some have a much larger tank, so that a supply sufficient to last several days may be maintained. A larger tank is also necessary where water is supplied to the house and barns.

The simplest system of this kind is one with the tank in the attic or on the roof supplying water to the kitchen only. When the expense can be afforded a hot-water tank may be placed in the kitchen and the water plumbing be extended to a bathroom.

The pump for this system must be a force pump, which not only raises water to its own level by suction but forces it to greater heights, according to the power applied. The pump may be placed over the well or in any other convenient spot as long as the suction lift does not exceed 20 feet. A three-way valve on such a pump permits the operator to direct the water to the tank or through the pump spout, as desired. The pump may be operated by hand, but where much water is to be pumped to a considerable height a windmill, a small gas engine, or an electric motor will save much time and exertion.

Plate IX, figure 2, shows an excellent outside elevated-tank system supplied by a steel windmill. This tank is of about 2,500 gallons capacity and supplies water to the house and barns. It is often possible to supply such a tank with a small gas-engine pumping plant, which may be situated in a shed constructed around the foot of the tower.

The great objection to an elevated-tank system is that in the colder climates there is danger of the water in the tank freezing. This is particularly objectionable when the tank is located in the attic, where considerable damage may be caused if it should burst. It is also necessary to provide an especially strong support for the tank. Another objection is that if located in the attic the tank is likely to catch considerable filth. It should, in such cases, be easily accessible for more or less frequent cleaning. It is well also to cover the tank to prevent, as far as possible, the entrance of dirt and vermin, and when placed on a tower outside it should be covered to prevent the breeding of mosquitoes.

The great advantages of this system are its cheapness and simplicity. All that is needed are a force pump, a storage tank, a pipe from the pump to the tank, a pipe from the tank to the point at which water is used, and accompanying fixtures. The tank should have an overflow pipe, particularly if located in the attic.

A number of such systems are in successful use. If well constructed and maintained, they afford a satisfactory, convenient, and comparatively cheap farm water supply. Although more generally successful in the warmer climates, such systems may with proper protection and attention be often used with success in colder climates.

An improvement over the elevated-tank system is the hydropneumatic system, which does away with the dangers of freezing and filth accumulation.

THE HYDROPNEUMATIC SYSTEM.

In the hydropneumatic system a water and air tight tank is placed in the basement or almost anywhere in the immediate vicinity of the house where there is no danger from freezing. This tank is usually connected by a 1¼-inch pipe to the three-way valve of a force pump for the well or cistern. The pump preferably is so equipped as to pump a little air at each stroke in addition to the water. At the start of pumping the tank is full of air, but as pumping continues this air is gradually compressed by the entering water until the required pressure, usually 25 to 40 pounds, is indicated on a pressure gauge.

One pound of pressure will force the water approximately 2 feet high in the house, so that for the ordinary house a pressure greater than 40 pounds is not necessary.

For the average family a tank at least 30 inches in diameter and 6 feet long, with a capacity of 220 gallons, is required. At 40 pounds' pressure this tank will be nearly three-fourths full of water and will deliver about 130 gallons to the second story and a greater proportion of the total capacity to the kitchen. Tanks of larger or smaller capacity may be secured if desired.

Figure 4 shows the main features in the installation of such a system with the tank in the house basement. The hot-water pipes are shown in black. The pump may be over the well as shown, or in the cellar next to the tank if the well is not too deep nor too far from the house.

The equipment necessary for an installation of this kind consists of a steel tank of the desired size, with pressure gauge and gauge glass, an air and water force pump, pipes, and connections, a 30 to 40 gallon hot-water tank, and the desired fixtures. A system of this kind, if well installed, affords a satisfactory and convenient water supply available at the turning of a faucet. It is perhaps more expensive than the elevated-tank system, but also does not have many of the objectionable features connected with that system. Water may be pumped for this system by hand, but, as in the elevated-tank system, where the desired pressure is above 20 to 25 pounds, a windmill, small gas engine, or small electric motor is necessary.

POWER FOR PUMPING.

A gas engine rated at from ½ to 1¼ horsepower should be of sufficient power for ordinary farm pumping. It may be connected with the pump directly or by a belt.

In the first case, the engine is usually used for pumping only and may be arranged about as shown in Plate IX, figure 3. It is usually desirable in such a case to provide a shelter for the engine, at least.

In the second case the engine is more likely used for several purposes about the farm and may be a portable engine, or it may be located in a shed near the pump. In either event, if the pump is equipped with a pumping jack and belt wheel it may be operated by the engine by means of a belt.

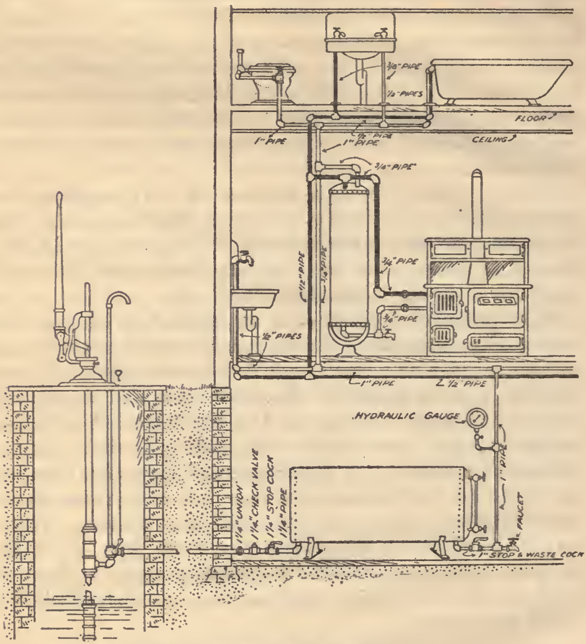


FIG. 4.—Pneumatic tank supply system with tank in basement supplied by hand force pump.

A good windmill is a cheap source of pumping power if well taken care of. A steel windmill is usually preferable to the wooden type. The mill itself costs considerable, it is true, but wind power thereafter costs nothing, while gasoline is a constant expense. The gas engine will, on the other hand, pump water whether the wind blows or not. On the whole, however, in localities where the wind is steadily fairly strong a windmill should be a satisfactory pumping power. Where electricity is available an electric motor rated at ½ to ¾ horsepower is usually sufficient for ordinary farm pumping.

If spring water is used the hydraulic ram is usually the best method of pumping water to the house if the spring is so located that the water can not be piped directly by gravity.

THE HYDRAULIC RAM.

The hydraulic ram is a simple, though rather wasteful, machine which utilizes the momentum of a stream of water falling a small height to elevate a small part of that water to a greater height. In this way a spring if properly connected

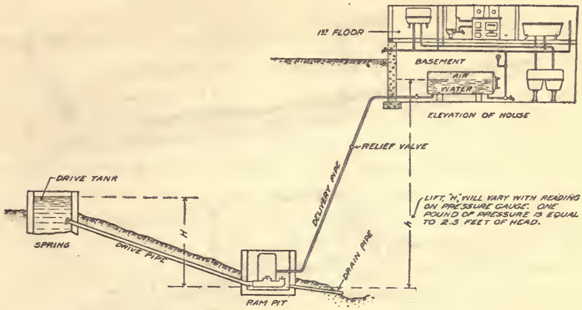


FIG. 5.—Hydraulic ram pumping to a pneumatic tank supply system, showing usual relative positions of spring, ram, and storage tank.

with a hydraulic ram will do double duty, supplying the water and also the power for pumping.

Certain conditions are necessary, however, for the proper operation of such a system. The ram must be located lower than the spring and at the proper distance away. The fall from spring to ram must not be less than 2 feet, and the spring must supply not less than one-half gallon of water per minute. Most rams are, however, guaranteed to operate on not less than 2 gallons per minute. Figure 5 shows the usual relative positions of spring, ram, and storage tank.

The drive pipe is usually twice the size of the delivery pipe and the size of each depends on the size of the ram used. The length of the drive pipe is usually about seven times the height of fall, although this may vary between five and ten, depending on the height and distance to which water is to be delivered. Its length must ordinarily be equal to the vertical height to which the water is lifted and must never be less than three-fourths this height. It is well to add on the average about 2 feet to the length of the drive pipe for every 100 feet the water is carried horizontally.

Where the grade is small and it is therefore necessary to bring the water a long distance in order to get the desired fall a standpipe or reservoir may be placed in the line of the supply pipe at the proper distance from the ram, as shown in figure 6, and thus bring the effective pressure nearer the ram and prevent waste of pressure by friction in an unnecessarily long drive pipe.

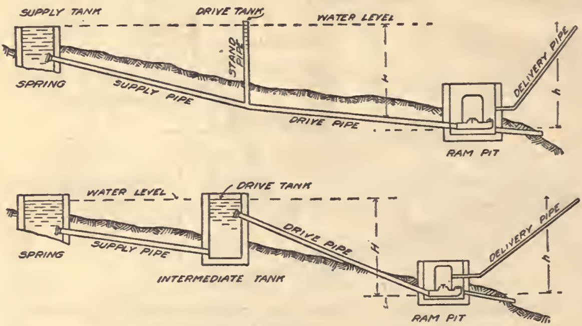


FIG. 6.—Two methods of securing the necessary fall in drive pipe.

Manufacturers of hydraulic rams make certain guarantees as to what their particular type of ram will accomplish under certain conditions. If one knows the quantity of flow of his spring, the elevation above the spring to which it is desired to deliver water, and the distance from the approximate location of the ram to the point of delivery, he can, by consulting the tables which manufacturers usually furnish, easily determine the size of ram, length and size of drive pipe, and usually the minimum permissible fall in the drive pipe to suit his particular case. Thus the smallest sizes of some makes of hydraulic ram are guaranteed to operate under a minimum fall of 3 feet with a supply of 2 to 3 gallons of water per minute and lift 10 to 15 gallons of water per hour to a height of about 20 feet. The larger sizes will deliver 150 to 300 gallons per hour to a height of 100 to 120 feet under proper working conditions. The proportion of water supplied to the ram which is elevated to the point of use will vary according to operating conditions from about two-sevenths for the lower lifts to one-twentieth for the higher lifts. In order to secure their guarantee it is well to follow closely the directions for installation given out by the manufacturers of the ram.

It is always well to house the ram in to protect it from freezing and to prevent the entrance of sand and grit to the drive pipe by screening the open end. Sand and grit will soon prevent the proper action of the valves. The pipes should also be placed below the frost line. In setting a ram the foundation should be firm and level. The drive pipe should be laid on a perfectly straight incline without bends or curves except where the pipe enters the ram, and this should be made by bending the pipe. Fittings should be used only where absolutely necessary. The upper end of the drive pipe should be sufficiently below the surface of the water to prevent air suction—at least a foot. Above all things the drive pipe should be air-tight.

The delivery pipe may be laid with the necessary bends, according to the usual practice in laying water pipes, but all pipes should be connected before starting the ram and they should be left uncovered until all leaks are stopped. There should be as few bends and elbows in the delivery pipe as possible in order to reduce friction.

Taken as a whole, the hydraulic-ram pumping system is a very convenient one. Of course it requires a certain amount of watching and care, but the ram is so simple that if properly installed it is easily kept in working order. It operates day and night, winter and summer, whether the wind blows or not, and regardless of the price of gasoline or electricity, and its operation is continuous until stopped. In some respects, therefore, it has the advantage over the windmill and gas engine.

CONCLUSION.

Methods for safeguarding the purity of farm water supplies are being given more and more attention by progressive farmers, and the value of clean water from the standpoint of health is now recognized. The rural inhabitant, therefore, realizing his obligation to his family and to himself in this respect, should see to it that clean and wholesome water is provided for household uses. This necessitates in the main the use of effective measures for protecting wells, springs, and other sources of farm water supplies from surface and subsurface pollution and that, above all things else, clean well surroundings be maintained. Further, to avoid trouble in the future, a spirit of constant watchfulness and care with reference to maintaining the purity of the water supply may well be developed.

In addition, simple, economical, and practical means of obtaining running water in the house have been found which, when properly and carefully installed, do away with much of the drudgery formerly borne largely by the farm housewife.

The farmer of average means can not afford to overlook the advantages offered by these more modern methods and arrangements for securing running water in the house; and when the expenditure in time and energy for carrying water is compared with the actual cost of installing the cheaper and simpler means of providing a convenient water supply in the house, it is believed a step in this direction by even the less well-to-do farmer would be, in the long run, a decided saving and advantage.

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